

Add to Marked List

Search for low mass vector resonances decaying into quark-antiquark pairs in proton-proton collisions at root s=13 TeV

by: Sirunyan, AM (Sirunyan, A. M.)^[1]; Tumasyan, A (Tumasyan, A.)^[1]; Adam, W (Adam, W.)^[2]; Ambrogio, F (Ambrogio, F.)^[2]; Asilar, E (Asilar, E.)^[2]; Bergauer, T (Bergauer, T.)^[2]; Brandstetter, J (Brandstetter, J.)^[2]; Brondolin, E (Brondolin, E.)^[2]; Dragicevic, M (Dragicevic, M.)^[2]; Ero, J (Ero, J.)^[2] ...More

Group Author(s): CMS Collaboration

[View ResearcherID and ORCID](#)

JOURNAL OF HIGH ENERGY PHYSICS

Issue: 1

Article Number: 097

DOI: 10.1007/JHEP01(2018)097

Published: JAN 22 2018

Document Type: Article

[View Journal Impact](#)

Abstract

A search for narrow vector resonances decaying into quark-antiquark pairs is presented. The analysis is based on data collected in proton-proton collisions at root s = 13 TeV with the CMS detector at the LHC, corresponding to an integrated luminosity of 35.9 fb⁻¹. The hypothetical resonance is produced with sufficiently high transverse momentum that its decay products are merged into a single jet with two-prong substructure. A signal would be identified as a peak over a smoothly falling background in the distribution of the invariant mass of the jet, using novel jet substructure techniques. No evidence for such a resonance is observed within the mass range of 50-300 GeV. Upper limits at 95% confidence level are set on the production cross section, and presented in a mass-coupling parameter space. The limits further constrain simplified models of dark matter production involving a mediator interacting between quarks and dark matter particles through a vector or axial-vector current. In the framework of these models, the results are the most sensitive to date, extending for the first time the search region to masses below 100 GeV.

Keywords

Author Keywords: Jet substructure; Hadron-Hadron scattering (experiments); Dark matter; Jets

KeyWords Plus: DARK-MATTER; P(P)OVER-BAR COLLISIONS; PARTICLES; COLLIDER; COMPUTATION; DIJETS; BOSONS

Author Information

Reprint Address: Sirunyan, AM (reprint author)

+ Yerevan Phys Inst, Yerevan, Armenia.

- Addresses:**
- + [1] Yerevan Phys Inst, Yerevan, Armenia
 - [2] Inst Hochenergiephys, Vienna, Austria
 - [3] Inst Nucl Problems, Minsk, BELARUS
 - + [4] Univ Antwerp, Antwerp, Belgium
 - + [5] Vrije Univ Brussel, Brussels, Belgium
 - + [6] Univ Libre Bruxelles, Brussels, Belgium
 - + [7] Univ Ghent, Ghent, Belgium
 - + [8] Catholic Univ Louvain, Louvain, Belgium
 - + [9] Ctr Brasileiro Pesquisas Fis, Rio De Janeiro, Brazil
 - + [10] Univ Estado Rio de Janeiro, Rio De Janeiro, Brazil
 - + [11] Univ Estadual Paulista, Sao Paulo, Brazil
 - + [12] Univ Fed ABC, Sao Paulo, Brazil
 - + [13] Bulgaria Acad Sci, Inst Nucl Res & Nucl Energy, Sofia, Bulgaria

Citation Network

In Web of Science Core Collection

4

Times Cited

Create Citation Alert

All Times Cited Counts

4 in All Databases

[See more counts](#)

78

Cited References

[View Related Records](#)

Most recently cited by:

- Trevisani, Nicola.
[Collider Searches for Dark Matter \(ATLAS. UNIVERSE \(2018\)](#)
- Batell, Brian; Freitas, Ayres; Ismail, Ahmed; et al.
[Flavor-specific scalar mediators. PHYSICAL REVIEW D \(2018\)](#)

[View All](#)

Use in Web of Science

Web of Science Usage Count

6

29

Last 180 Days

Since 2013












































[Learn more](#)

This record is from:
Web of Science Core Collection
- Science Citation Index Expanded

Suggest a correction

If you would like to improve the quality of the data in this record, please [suggest a correction](#).

- [+](#) [14] Univ Sofia, Sofia, Bulgaria
- [+](#) [15] Beihang Univ, Beijing, Peoples R China
- [+](#) [16] Inst High Energy Phys, Beijing, Peoples R China
- [+](#) [17] Peking Univ, State Key Lab Nucl Phys & Technol, Beijing, Peoples R China
- [+](#) [18] Univ Los Andes, Bogota, Colombia
- [+](#) [19] Univ Split, Fac Elect Engrn, Mech Engrn & Naval Architecture, Split, Croatia
- [+](#) [20] Univ Split, Fac Sci, Split, Croatia
- [+](#) [21] Inst Rudjer Boskovic, Zagreb, Croatia
- [+](#) [22] Univ Cyprus, Nicosia, Cyprus
- [+](#) [23] Charles Univ Prague, Prague, Czech Republic
- [24] Univ San Francisco Quito, Quito, Ecuador
- [+](#) [25] Acad Sci Res & Technol Arab Republ Egypt, Egyptian Network High Energy Phys, Cairo, Egypt
- [+](#) [26] NICPB, Tallinn, Estonia
- [+](#) [27] Univ Helsinki, Dept Phys, Helsinki, Finland
- [+](#) [28] Helsinki Inst Phys, Helsinki, Finland
- [+](#) [29] Lappeenranta Univ Technol, Lappeenranta, Finland
- [+](#) [30] Univ Paris Saclay, CEA, IRFU, Gif Sur Yvette, France
- [+](#) [31] Univ Paris Saclay, CNRS, Ecole Polytech, Lab Leprince Ringuet,IN2P3, Palaiseau, France
- [+](#) [32] Univ Strasbourg, CNRS, IPHC, UMR 7178, F-67000 Strasbourg, France
- [+](#) [33] CNRS, Ctr Calcul, Inst Natl Phys Nucl & Phys Particules, IN2P3, Villeurbanne, France
- [+](#) [34] Univ Claude Bernard Lyon 1, Univ Lyon, CNRS, IN2P3,Inst Phys Nucl Lyon, Villeurbanne, France
- [+](#) [35] Georgian Tech Univ, Tbilisi, Rep of Georgia
- [+](#) [36] Tbilisi State Univ, Tbilisi, Rep of Georgia
- [+](#) [37] Rhein Westfal TH Aachen, Phys Inst 1, Aachen, Germany
- [+](#) [38] Rhein Westfal TH Aachen, Phys Inst A 3, Aachen, Germany
- [+](#) [39] Rhein Westfal TH Aachen, Phys Inst B 3, Aachen, Germany
- [+](#) [40] DESY, Hamburg, Germany
- [+](#) [41] Univ Hamburg, Hamburg, Germany
- [42] Inst Expt Kernphys, Karlsruhe, Germany
- [+](#) [43] NCSR Demokritos, Inst Nucl & Particle Phys, Aghia Paraskevi, Greece
- [+](#) [44] Univ Athens, Athens, Greece
- [+](#) [45] Natl Tech Univ Athens, Athens, Greece
- [+](#) [46] Univ Ioannina, Ioannina, Greece
- [+](#) [47] Univ Lorand Eotvos, MTA ELTE Lendulet CMS Particle & Nucl Phys Grp, Budapest, Hungary
- [+](#) [48] Wigner Res Ctr Phys, Budapest, Hungary
- [+](#) [49] Inst Nucl Res ATOMKI, Debrecen, Hungary
- [+](#) [50] Univ Debrecen, Inst Phys, Debrecen, Hungary
- [+](#) [51] Indian Inst Sci IISc, Bangalore, Karnataka, India
- [+](#) [52] Natl Inst Sci Educ & Res, Bhubaneswar, Orissa, India
- [+](#) [53] Panjab Univ, Chandigarh, India
- [54] Univ Delhi, Delhi, India
- [+](#) [55] HBNi, Saha Inst Nucl Phys, Kolkata, India
- [+](#) [56] Indian Inst Technol Madras, Madras, Tamil Nadu, India
- [+](#) [57] Bhabha Atom Res Ctr, Bombay, Maharashtra, India
- [58] Tata Inst Fundamental Res A, Bombay, Maharashtra, India
- [59] Tata Inst Fundamental Res B, Mumbai, Maharashtra, India
- [+](#) [60] Indian Inst Sci Educ & Res, Pune, Maharashtra, India
- [61] Inst Res Fundamental Sci IPM, Tehran, Iran
- [+](#) [62] Univ Coll Dublin, Dublin, Ireland

-  [63] Ist Nazl Fis Nucl, Sez Bari, Bari, Italy
-  [64] Univ Bari, Bari, Italy
-  [65] Politecn Bari, Bari, Italy
-  [66] Ist Nazl Fis Nucl, Sez Bologna, Bologna, Italy
-  [67] Univ Bologna, Bologna, Italy
-  [68] Ist Nazl Fis Nucl, Sez Catania, Catania, Italy
-  [69] Univ Catania, Catania, Italy
-  [70] Ist Nazl Fis Nucl, Sez Firenze, Florence, Italy
-  [71] Univ Florence, Florence, Italy
-  [72] Ist Nazl Fis Nucl, Lab Nazl Frascati, Frascati, Italy
-  [73] Ist Nazl Fis Nucl, Sez Genova, Genoa, Italy
-  [74] Univ Genoa, Genoa, Italy
-  [75] Ist Nazl Fis Nucl, Sez Milano Bicocca, Milan, Italy
-  [76] Univ Milano Bicocca, Milan, Italy
-  [77] Ist Nazl Fis Nucl, Sez Napoli, Naples, Italy
-  [78] Univ Napoli Federico II, Naples, Italy
-  [79] Univ Basilicata, Potenza, Italy
- [80] Univ G Marconi, Rome, Italy
-  [81] Ist Nazl Fis Nucl, Sez Padova, Padua, Italy
-  [82] Univ Padua, Padua, Italy
-  [83] Univ Trento, Trento, Italy
-  [84] Ist Nazl Fis Nucl, Sez Pavia, Pavia, Italy
-  [85] Univ Pavia, Pavia, Italy
-  [86] Ist Nazl Fis Nucl, Sez Perugia, Perugia, Italy
-  [87] Univ Perugia, Perugia, Italy
-  [88] Ist Nazl Fis Nucl, Sez Pisa, Pisa, Italy
-  [89] Univ Pisa, Pisa, Italy
-  [90] Scuola Normale Super Pisa, Pisa, Italy
-  [91] Ist Nazl Fis Nucl, Sez Roma, Rome, Italy
-  [92] Sapienza Univ Roma, Rome, Italy
-  [93] Ist Nazl Fis Nucl, Sez Torino, Turin, Italy
-  [94] Univ Turin, Turin, Italy
-  [95] Univ Piemonte Orientale, Novara, Italy
-  [96] Ist Nazl Fis Nucl, Sez Trieste, Trieste, Italy
-  [97] Univ Trieste, Trieste, Italy
-  [98] Kyungpook Natl Univ, Daegu, South Korea
-  [99] Chonbuk Natl Univ, Jeonju, South Korea
-  [100] Chonnam Natl Univ, Inst Universe & Elementary Particles, Kwangju, South Korea
-  [101] Hanyang Univ, Seoul, South Korea
-  [102] Korea Univ, Seoul, South Korea
-  [103] Seoul Natl Univ, Seoul, South Korea
-  [104] Univ Seoul, Seoul, South Korea
-  [105] Sungkyunkwan Univ, Suwon, South Korea
-  [106] Vilnius Univ, Vilnius, Lithuania
-  [107] Univ Malaya, Natl Ctr Particle Phys, Kuala Lumpur, Malaysia
-  [108] IPN, Ctr Invest & Estud Avanzados, Mexico City, DF, Mexico
- [109] Univ Iberoamer, Mexico City, DF, Mexico
-  [110] Benemerita Univ Autonoma Puebla, Puebla, Mexico
-  [111] Univ Autonoma San Luis Potosi, San Luis Potosi, Mexico

- [+](#) [112] Univ Auckland, Auckland, New Zealand
- [+](#) [113] Univ Canterbury, Christchurch, New Zealand
- [+](#) [114] Quaid I Azam Univ, Natl Ctr Phys, Islamabad, Pakistan
- [+](#) [115] Natl Ctr Nucl Res, Otwock, Poland
- [+](#) [116] Univ Warsaw, Fac Phys, Inst Expt Phys, Warsaw, Poland
- [+](#) [117] Lab Instrumentacao & Fis Expt Particulas, Lisbon, Portugal
- [+](#) [118] Joint Inst Nucl Res, Dubna, Russia
- [+](#) [119] Petersburg Nucl Phys Inst, St Petersburg, Russia
- [+](#) [120] Inst Nucl Res, Moscow, Russia
- [+](#) [121] Inst Theoret & Expt Phys, Moscow, Russia
- [+](#) [122] Moscow Inst Phys & Technol, Moscow, Russia
- [+](#) [123] Natl Res Nucl Univ, Moscow Engn Phys Inst MEPhI, Moscow, Russia
- [+](#) [124] PN Lebedev Phys Inst, Moscow, Russia
- [+](#) [125] Lomonosov Moscow State Univ, Skobeltsyn Inst Nucl Phys, Moscow, Russia
- [+](#) [126] Novosibirsk State Univ, Novosibirsk, Russia
- [+](#) [127] Inst High Energy Phys, State Res Ctr Russian Federat, Protvino, Russia
- [+](#) [128] Univ Belgrade, Fac Phys, Belgrade, Serbia
- [+](#) [129] Univ Belgrade, Vinca Inst Nucl Sci, Belgrade, Serbia
- [130] Ctr Invest Energet Medioambientales & Technol CIE, Madrid, Spain
- [+](#) [131] Univ Autonoma Madrid, Madrid, Spain
- [+](#) [132] Univ Oviedo, Oviedo, Spain
- [+](#) [133] Univ Cantabria, CSIC, Inst Fis Cantabria IFCA, Santander, Spain
- [+](#) [134] CERN, European Org Nucl Res, Geneva, Switzerland
- [+](#) [135] Paul Scherrer Inst, Villigen, Switzerland
- [136] Inst Particle Phys & Astrophys IPA, Zurich, Switzerland
- [+](#) [137] Univ Zurich, Zurich, Switzerland
- [+](#) [138] Natl Cent Univ, Chungli, Taiwan
- [+](#) [139] Natl Taiwan Univ, Taipei, Taiwan
- [+](#) [140] Chulalongkorn Univ, Fac Sci, Dept Phys, Bangkok, Thailand
- [+](#) [141] Cukurova Univ, Sci & Art Fac, Phys Dept, Adana, Turkey
- [+](#) [142] Middle East Tech Univ, Phys Dept, Ankara, Turkey
- [+](#) [143] Bogazici Univ, Istanbul, Turkey
- [+](#) [144] Istanbul Tech Univ, Istanbul, Turkey
- [+](#) [145] Natl Acad Sci Ukraine, Inst Scintillat Mat, Kharkov, Ukraine
- [+](#) [146] Kharkov Inst Phys & Technol, Natl Sci Ctr, Kharkov, Ukraine
- [+](#) [147] Univ Bristol, Bristol, Avon, England
- [+](#) [148] Rutherford Appleton Lab, Didcot, Oxon, England
- [+](#) [149] Imperial Coll, London, England
- [+](#) [150] Brunel Univ, Uxbridge, Middx, England
- [+](#) [151] Baylor Univ, Waco, TX 76798 USA
- [+](#) [152] Catholic Univ Amer, Washington, DC 20064 USA
- [+](#) [153] Univ Alabama, Tuscaloosa, AL USA
- [+](#) [154] Boston Univ, Boston, MA 02215 USA
- [+](#) [155] Brown Univ, Providence, RI 02912 USA
- [+](#) [156] Univ Calif Davis, Davis, CA 95616 USA
- [+](#) [157] Univ Calif Los Angeles, Los Angeles, CA USA
- [+](#) [158] Univ Calif Riverside, Riverside, CA 92521 USA
- [+](#) [159] Univ Calif San Diego, La Jolla, CA 92093 USA
- [+](#) [160] Univ Calif Santa Barbara, Dept Phys, Santa Barbara, CA 93106 USA

- [+](#) [161] CALTECH, Pasadena, CA 91125 USA
- [+](#) [162] Carnegie Mellon Univ, Pittsburgh, PA 15213 USA
- [+](#) [163] Univ Colorado, Boulder, CO 80309 USA
- [+](#) [164] Cornell Univ, Ithaca, NY USA
- [+](#) [165] Fermilab Natl Accelerator Lab, POB 500, Batavia, IL 60510 USA
- [+](#) [166] Univ Florida, Gainesville, FL USA
- [+](#) [167] Florida Int Univ, Miami, FL 33199 USA
- [+](#) [168] Florida State Univ, Tallahassee, FL 32306 USA
- [+](#) [169] Florida Inst Technol, Melbourne, FL 32901 USA
- [+](#) [170] UIC, Chicago, IL USA
- [+](#) [171] Univ Iowa, Iowa City, IA USA
- [+](#) [172] Johns Hopkins Univ, Baltimore, MD USA
- [+](#) [173] Univ Kansas, Lawrence, KS 66045 USA
- [+](#) [174] Kansas State Univ, Manhattan, KS 66506 USA
- [+](#) [175] Lawrence Livermore Natl Lab, Livermore, CA USA
- [+](#) [176] Univ Maryland, College Pk, MD 20742 USA
- [+](#) [177] MIT, Cambridge, MA 02139 USA
- [+](#) [178] Univ Minnesota, Minneapolis, MN USA
- [+](#) [179] Univ Mississippi, Oxford, MS USA
- [+](#) [180] Univ Nebraska, Lincoln, NE USA
- [+](#) [181] SUNY Buffalo, Buffalo, NY USA
- [+](#) [182] Northeastern Univ, Boston, MA 02115 USA
- [+](#) [183] Northeastern Univ, Evanston, IL USA
- [+](#) [184] Univ Notre Dame, Notre Dame, IN 46556 USA
- [+](#) [185] Ohio State Univ, Columbus, OH 43210 USA
- [+](#) [186] Princeton Univ, Princeton, NJ 08544 USA
- [+](#) [187] Univ Puerto Rico, Mayaguez, PR USA
- [+](#) [188] Purdue Univ, W Lafayette, IN 47907 USA
- [+](#) [189] Purdue Univ Northwest, Hammond, LA USA
- [+](#) [190] Rice Univ, Houston, TX USA
- [+](#) [191] Univ Rochester, Rochester, NY USA
- [+](#) [192] Rockefeller Univ, 1230 York Ave, New York, NY 10021 USA
- [+](#) [193] Rutgers State Univ, Piscataway, NJ USA
- [+](#) [194] Univ Tennessee, Knoxville, TN USA
- [+](#) [195] Texas A&M Univ, College Stn, TX USA
- [+](#) [196] Texas Tech Univ, Lubbock, TX 79409 USA
- [+](#) [197] Vanderbilt Univ, 221 Kirkland Hall, Nashville, TN 37235 USA
- [+](#) [198] Univ Virginia, Charlottesville, VA USA
- [+](#) [199] Wayne State Univ, Detroit, MI USA
- [+](#) [200] Univ Wisconsin, Madison, WI USA
- [+](#) [201] Vienna Univ Technol, Vienna, Austria
- [+](#) [202] Peking Univ, State Key Lab Nucl Phys & Technol, Beijing, Peoples R China
- [+](#) [203] Univ Paris Saclay, CEA, IRFU, Gif Sur Yvette, France
- [+](#) [204] Univ Estadual Campinas, Campinas, SP, Brazil
- [+](#) [205] Univ Fed Pelotas, Pelotas, Brazil
- [+](#) [206] Ain Shams Univ, Cairo, Egypt
- [+](#) [207] British Univ Egypt, Cairo, Egypt
- [+](#) [208] Cairo Univ, Cairo, Egypt
- [+](#) [209] Univ Haute Alsace, Mulhouse, France

- +

[210] Brandenburg Tech Univ Cottbus, Cottbus, Germany
- +

[211] Indian Inst Technol Bhubaneswar, Bhubaneswar, Orissa, India
- +

[212] Inst Phys, Bhubaneswar, Orissa, India
- +

[213] Univ Visva Bharati, Santini Ketan, W Bengal, India
- [214] Univ Ruhuna, Matara, Sri Lanka
- +

[215] Isfahan Univ Technol, Esfahan, Iran
- +

[216] Yazd Univ, Yazd, Iran
- +

[217] Islamic Azad Univ, Sci & Res Branch, Plasma Phys Res Ctr, Tehran, Iran
- +

[218] Univ Siena, Siena, Italy
- +

[219] Int Islamic Univ Malaysia, Kuala Lumpur, Malaysia
- +

[220] MOSTI, Malaysian Nucl Agcy, Kajang, Malaysia
- [221] Consejo Nacl Invest Cient & Tecn, Mexico City, DF, Mexico
- +

[222] Warsaw Univ Technol, Inst Elect Syst, Warsaw, Poland
- +

[223] St Petersburg State Polytech Univ, St Petersburg, Russia
- +

[224] Budker Inst Nucl Phys, Novosibirsk, Russia
- +

[225] Ist Nazl Fis Nucl, Scuola Normale, Pisa, Italy
- +

[226] Ist Nazl Fis Nucl, Sez Pisa, Pisa, Italy
- +

[227] Riga Tech Univ, Riga, Latvia
- [228] Stefan Meyer Inst Subat Phys SMI, Vienna, Austria
- +

[229] Gaziosmanpasa Univ, Tokat, Turkey
- +

[230] Istanbul Aydin Univ, Istanbul, Turkey
- +

[231] Mersin Univ, Mersin, Turkey
- +

[232] Cag Univ, Mersin, Turkey
- +

[233] Piri Reis Univ, Istanbul, Turkey
- +

[234] Necmettin Erbakan Univ, Konya, Turkey
- +

[235] Marmara Univ, Istanbul, Turkey
- +

[236] Kafkas Univ, Kars, Turkey
- +

[237] Istanbul Bilgi Univ, Istanbul, Turkey
- +

[238] Univ Southampton, Sch Phys & Astron, Southampton, Hants, England
- +

[239] Inst Astrofis Canarias, San Cristobal la Laguna, Spain
- +

[240] Utah Valley Univ, Orem, UT USA
- +

[241] Beykent Univ, Istanbul, Turkey
- +

[242] Bingol Univ, Bingol, Turkey
- +

[243] Erzincan Univ, Erzincan, Turkey
- +

[244] Sinop Univ, Sinop, Turkey
- +

[245] Mimar Sinan Univ, Istanbul, Turkey
- +

[246] Texas A&M Univ Qatar, Doha, Qatar
- +

[247] Kyungpook Natl Univ, Daegu, South Korea

E-mail Addresses: cms-publication-committee-chair@cern.ch

Funding

Funding Agency	Grant Number
BMFWF (Austria)	
FWF (Austria)	
FNRS (Belgium)	
FWO (Belgium)	
CNPq (Brazil)	
CAPES (Brazil)	
FAPERJ (Brazil)	

FAPESP (Brazil)	
MES (Bulgaria)	
CERN	
CAS (China)	
MoST (China)	
NSFC (China)	
COLCIENCIAS (Colombia)	
MSES (Croatia)	
CSF (Croatia)	
RPF (Cyprus)	
SENESCYT (Ecuador)	
MoER (Estonia)	
ERC IUT (Estonia)	
ERDF (Estonia)	
Academy of Finland (Finland)	
MEC (Finland)	
HIP (Finland)	
CEA (France)	
CNRS/IN2P3 (France)	
BMBF (Germany)	
DFG (Germany)	
HGF (Germany)	
GSRT (Greece)	
OTKA (Hungary)	
NIH (Hungary)	
DAE (India)	
DST (India)	
IPM (Iran)	
SFI (Ireland)	
INFN (Italy)	
MSIP (Republic of Korea)	
NRF (Republic of Korea)	
LAS (Lithuania)	
MOE (Malaysia)	
UM (Malaysia)	
BUAP (Mexico)	
CINVESTAV (Mexico)	
CONACYT (Mexico)	
LNS (Mexico)	
SEP (Mexico)	
UASLP-FAI (Mexico)	
MBIE (New Zealand)	
PAEC (Pakistan)	
MSHE (Poland)	
NSC (Poland)	
FCT (Portugal)	
JINR (Dubna)	

MON (Russia)	
RosAtom (Russia)	
RAS (Russia)	
RFBR (Russia)	
RAEP (Russia)	
MESTD (Serbia)	
SEIDI (Spain)	
CPAN (Spain)	
PCTI (Spain)	
FEDER (Spain)	
Swiss Funding Agencies (Switzerland)	
MST (Taipei)	
ThEP Center (Thailand)	
IPST (Thailand)	
STAR (Thailand)	
NSTDA (Thailand)	
TUBITAK (Turkey)	
TAEK (Turkey)	
NASU (Ukraine)	
SFFR (Ukraine)	
STFC (United Kingdom)	
DOE (U.S.A.)	
NSF (U.S.A.)	
Marie-Curie programme	
European Research Council	
Horizon Grant (European Union)	675440
Leventis Foundation	
A. P. Sloan Foundation	
Alexander von Humboldt Foundation	
Belgian Federal Science Policy Office	
Fonds pour la Formation a la Recherche dans l'Industrie et dans l'Agriculture (FRIA-Belgium)	
Agentschap voor Innovatie door Wetenschap en Technologie (IWT-Belgium)	
Ministry of Education, Youth and Sports (MEYS) of the Czech Republic	
Council of Science and Industrial Research, India	
HOMING PLUS programme of the Foundation for Polish Science	
European Union, Regional Development Fund	
Mobility Plus programme of the Ministry of Science and Higher Education	
National Science Center (Poland)	Harmonia 2014/14/M/ST2/00428 Opus 2014/13/B/ST2/02543 2014/15/B/ST2/03998 2015/19/B/ST2/02861 Sonata-bis 2012/07/E/ST2/01406
National Priorities Research Program by Qatar National Research Fund	
Programa Severo Ochoa del Principado de Asturias	
EU-ESF	
Greek NSRF	
Chulalongkorn University	

Chulalongkorn Academic into Its 2nd Century Project Advancement Project (Thailand)	
Welch Foundation	C-1845
Weston Havens Foundation (U.S.A.)	
Thalis programme	
Aristeia programme	

[View funding text](#)

Publisher

SPRINGER, 233 SPRING ST, NEW YORK, NY 10013 USA

Categories / Classification

Research Areas: Physics

Web of Science Categories: Physics, Particles & Fields

[See more data fields](#)